Lighting Controls:

Reducing Market Barriers to Widespread Use of Energy-efficient Lighting Systems

(January 2003)

Sponsor: U.S. Department of Energy

Goals of the project

- Identify barriers to widespread use of lighting controls into commercial/industrial (C/I) applications that employ fluorescent lamp technologies, and to recommend means for overcoming these barriers

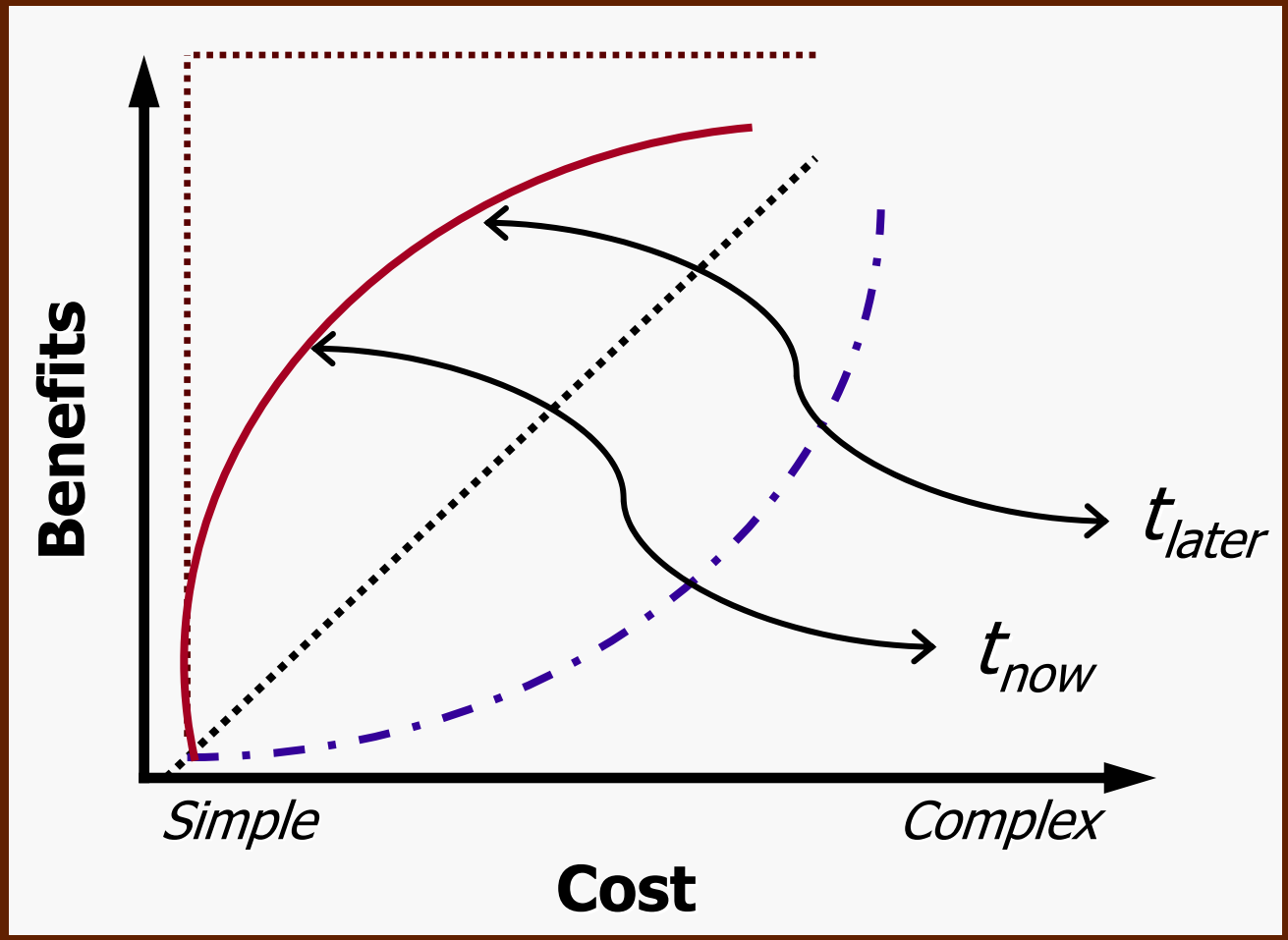
This project is not about: HID and incandescent
Architectural dimming
Residential

Barriers

- Lamp/ballast performance
  - cost, reduced lamp life
- Components compatibility
  - cost, hassle, uncertainty
- Installation/commissioning
  - cost, hassle, uncertainty
- Marketing
  - cost, hassle, uncertainty, occupant acceptance, reduced lamp life

Philosophy

Cost/benefit curve



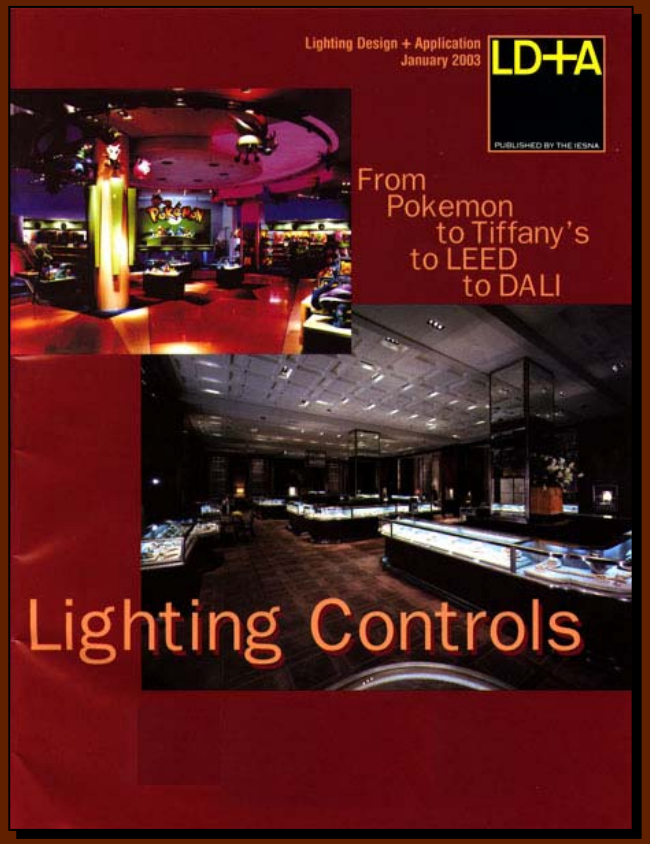
Lighting Controls:

Reducing Market Barriers to Widespread Use of Energy-efficient Lighting Systems – Year 2

	Technology focus			
Comments	Building automation	Automatic shut-off	Daylight dimming	Load management
Does not require emphasis (at this time)	✓			
Dimming: Human Factors and Lighting System Performance			✓	✓
Dimming: Lamp/ballast issues			✓ ✓ ✓	✓ ✓ ✓
Recommendations		✓	✓	✓
Occupancy Sensors: Statistical Savings		✓		
Occupancy Sensors: Best Practices		✓		

Building automation

Task 4.1



LD+A
January 2003

- Happening without help due to vested manufacturers interests – little we can and should do
- But…
  - Expensive platform
  - Costly commissioning
- And
  - No obvious benefits to mainstream C&I (productivity, satisfaction, etc)

Automatic shut-off

- Time clocks
- Occupancy sensors
- Panel relays
- Centralized controls

- These work,

  But implementation depends upon wiring-installation-commissioning, etc…

Automatic shut-off

- Aggressively encourage the widespread deployment of automatic shut-off lighting controls in existing and new C&I buildings
  - Best Practices Document
  - Approved Values for Savings Calculations

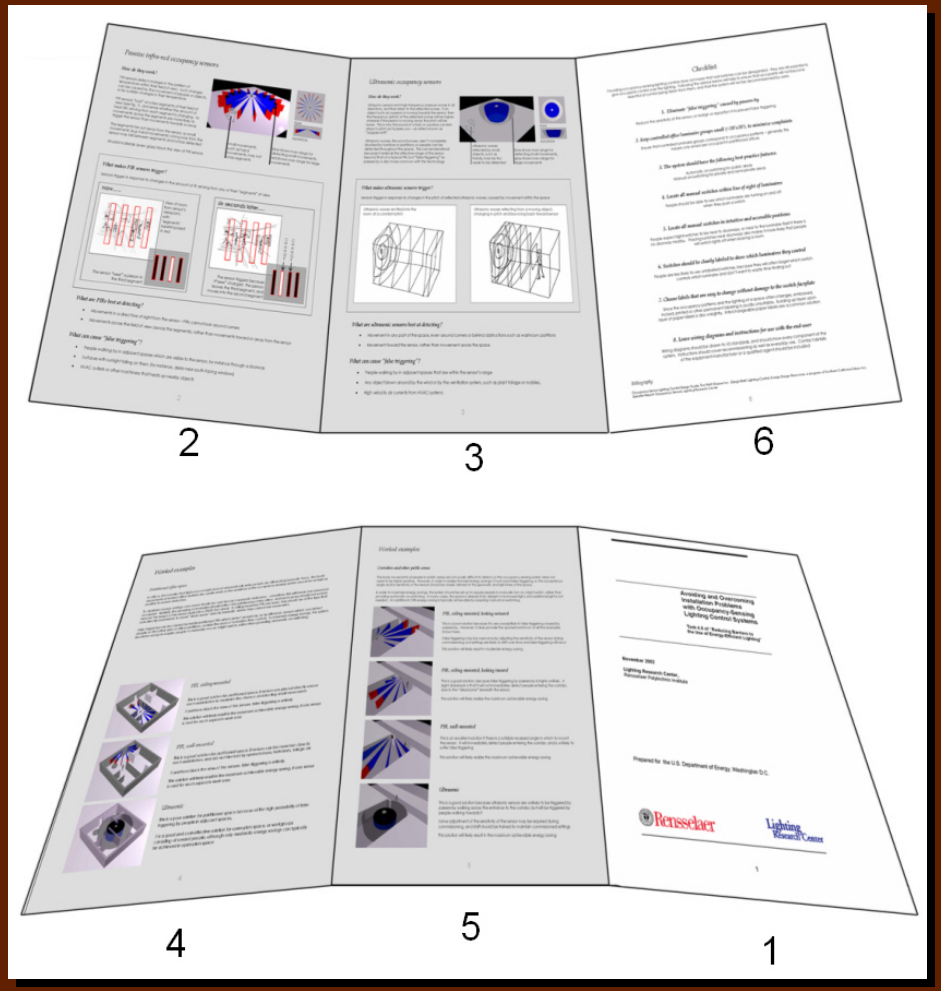
Automatic shut-off

- Survey of 26 case studies and manufacturers' claims

Percent savings from occupancy sensors (mean values)

	Private ("owned")	Shared
Sporadic use:	25	40
Scheduled use:		30

Automatic shut-off



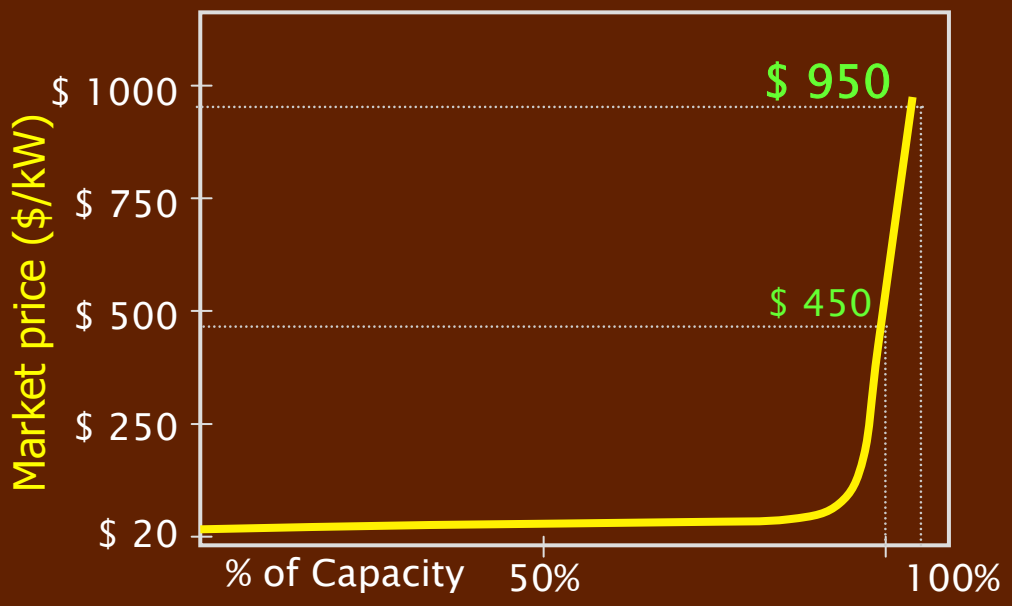
- Best Practices for Occupancy Sensors
  - Make an electrician-friendly document to overcome nagging installation barriers

Load management

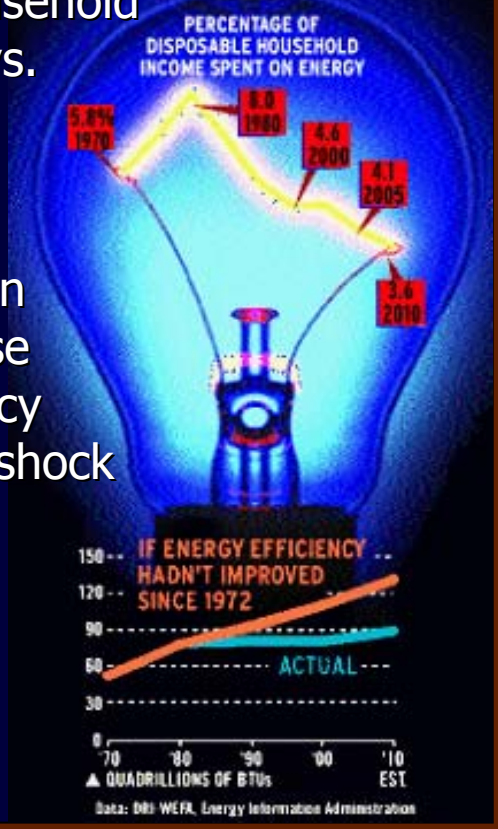
Energy efficiency is not just kWh anymore!

Energy efficiency is becoming more about when power is needed than how long power is needed; the real cost of power for certain days and certain times of the day can approach $1/W!

Electric market clearing prices



Why does energy grab fewer headlines that it did during energy crises of the 1970s? Because it costs less as a share of disposable household income these days. And the burden should continue to lighten. One big contributor: an enormous increase in energy efficiency since the first oil shock in 1973.



Businessweek

Load management

- Plus, society doesn't want to build new power stations and power lines (particularly in my backyard!)

Load-shedding, why lighting?

- Lighting is the ultimate distributed resource for load management
- Non-disruptive (especially with daylight)
- Non-polluting
- Constitutes a large load (40% of commercial load) with large periods of use
- Distributed load, high reliability
- Immediate response with no "rebound"
- Can be aggregated into larger loads
  - But requires a third party organization to do this

Joel S. Gilbert, P.E., CEO
APOGEE Interactive, Inc.
LRC Partner's Day 2002

Load management

- Technology Specification
  - Developing load-shed ballast performance specification
  - Investigating critical performance factors and lamp life

Load management

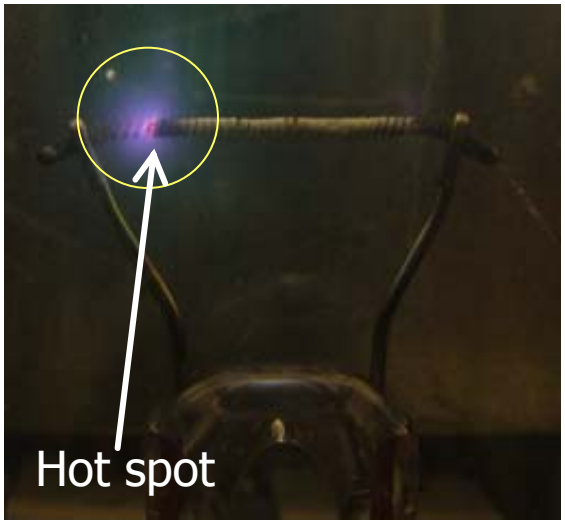
Technology specification

Instant start

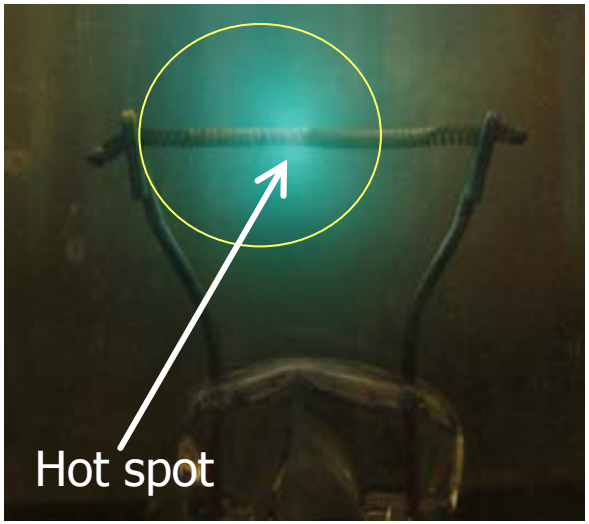
Small glow region = greatest damage concentration;
Note color of glow and incandescing filament

medium glow region

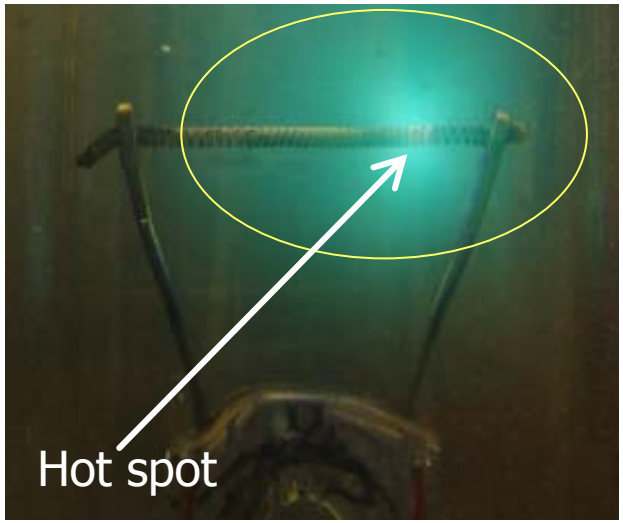
largest glow region



64 mA



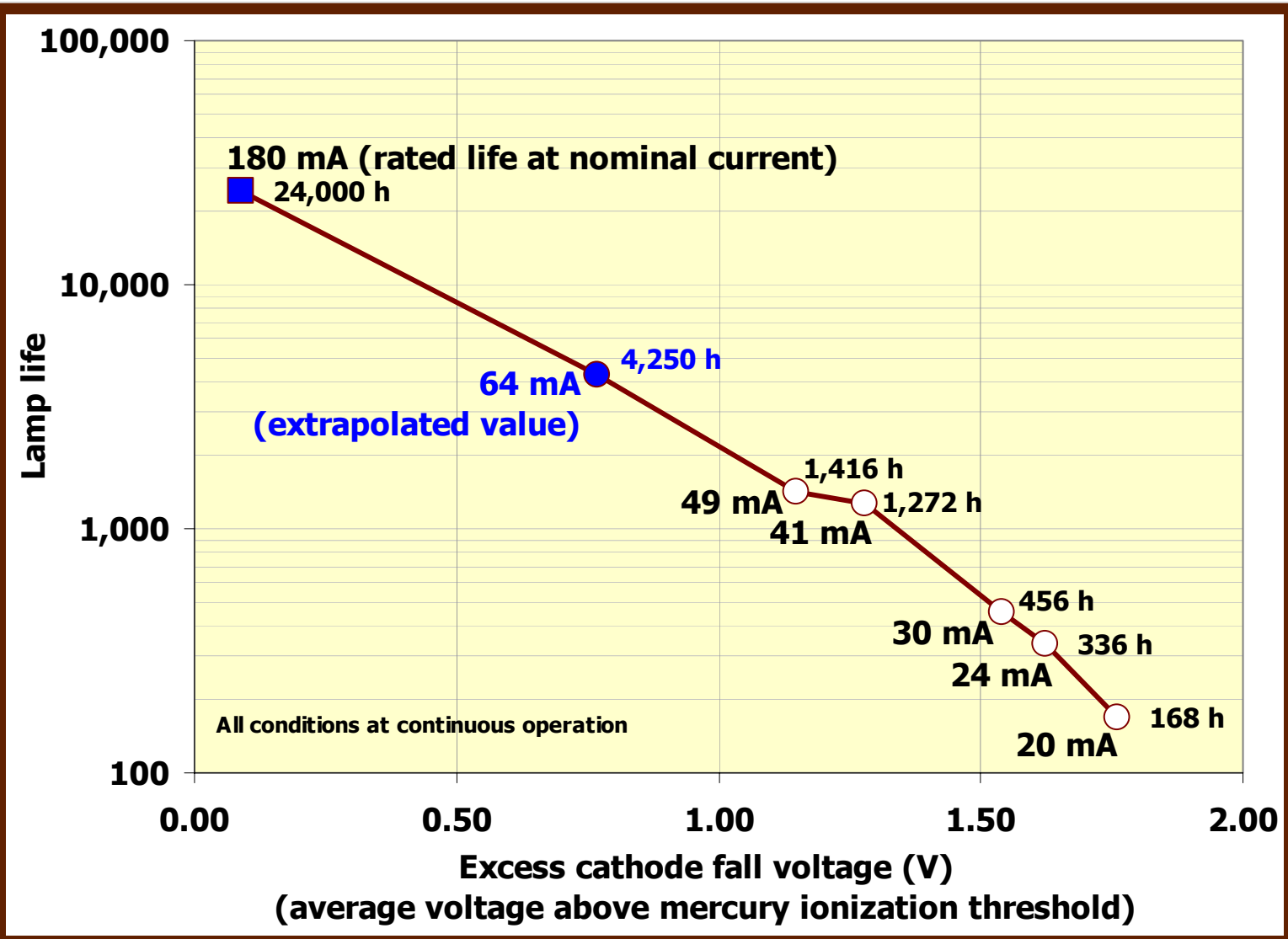
121 mA



180 mA

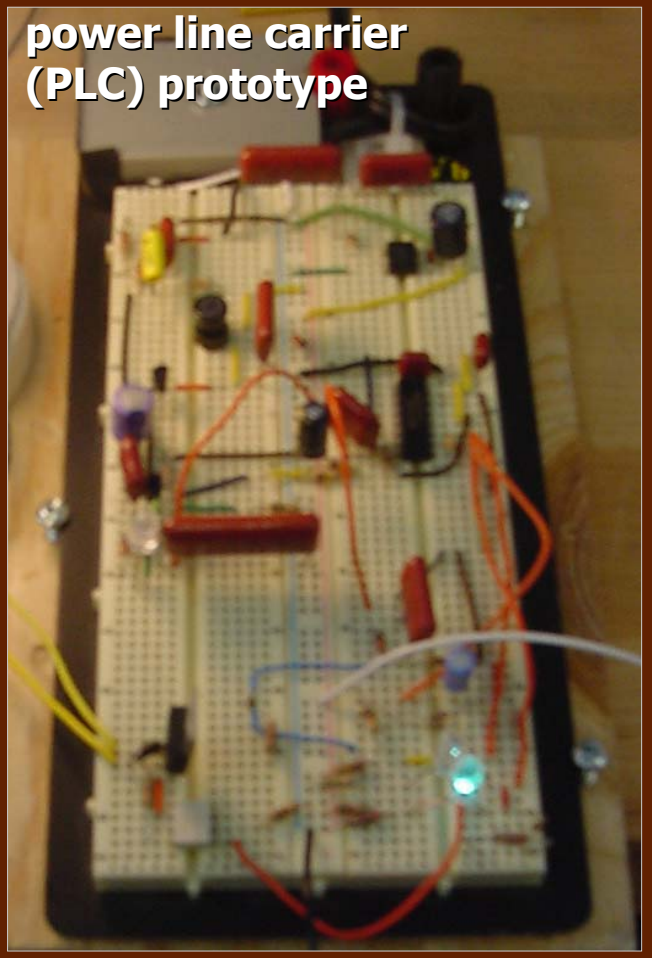
Load management

Technology specification



Load management

- Communication Protocol
  - Developing specification for communication protocols
  - Investigating most effective way to transmit the signal from the utility to the building to the ballast
- Large scale demonstration
  - Concentrating on within-building distribution of signal to ballast
  - Investigating low cost PLC receivers



Load management

Philosophy

- Technology Specification (switching and dimming)
  - Slight additions/modifications to existing non-dimming ballasts designs
  - Low incremental *cost* (< $1 per ballast)
  - Suitable for instant start and program start ballasts
- Communications Protocol
  - Low-cost power line carrier (PLC) receivers inside ballast case, < $2 per ballast
  - Ballast control modules serving 100s of ballasts < $0.50 per ballast

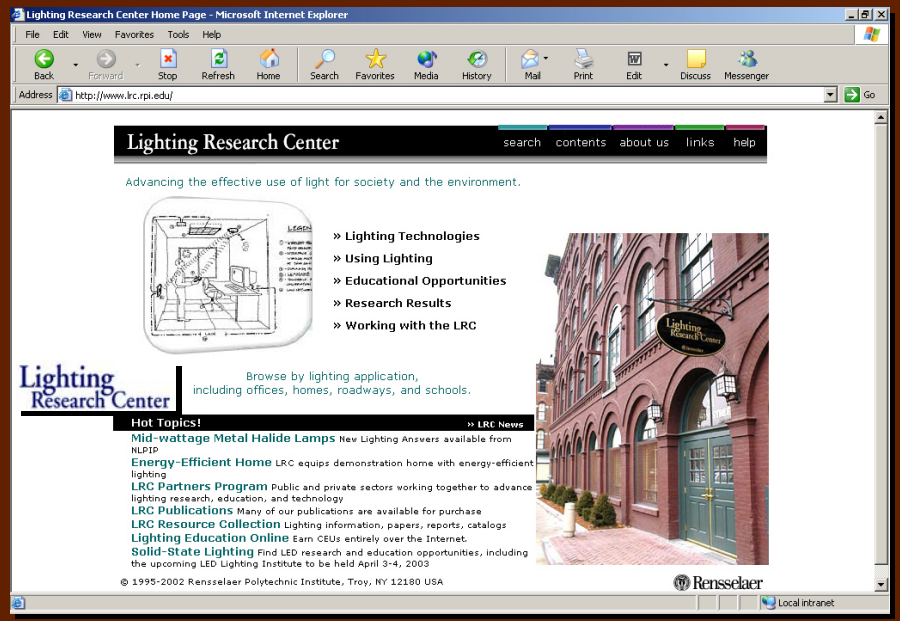
Year 3

CEE CONSORTIUM FOR ENERGY EFFICIENCY

FEMP FEDERAL ENERGY MANAGEMENT PROGRAM

ACE3

IES



Marketing and Technology Transfer

- Federal and government agencies
- Professionals
  - Public (Website)
- And
  - Energy policy makers

Federal Energy Regulatory Commission
Promoting dependable, affordable energy through sustained competitive markets.

Acknowledgements

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Thanks to the US Department of Energy

"The goal of the DOE's competitive Lighting Research and Development (LR&D) Program is to develop viable technologies having the technical potential to conserve 50% of lighting consumption by 2010. The Program partners with industry, utilities, universities, and research institutions to create energy efficient lighting technologies in pursuit of this goal."

Photosensor Results

Features

- Sliding setpoint algorithm
- Wireless, remote sensor
- Self-commissioning (minimal user interaction)
- Occupant preference adjustment independent of commissioning
- Switching in addition to dimming control
- Compact size (replaces std. switch)
- Efficient operation (~1.2 watts @ 120 Vac)
- Microprocessor based

Commissioning time
< 3 minutes
in most cases!

Energy Savings Results

June 21 through September 21, 2002

Location	With	Without	Energy Saved	
	kWh	kWh	kWh	%
LRC, Andy	2.37	8.41	6.04	72
LRC, Sandra	8.02	21.85	13.82	63
NU-East, 1-22B	117.4	197.8	80.5	41
NU-East, 1-19H	54.3	70.8	16.5	23
NU-East, 2-21H	80.0	112.8	32.8	29
NU, Mutchler	176.6	186.1	9.5	5
Hartford, Tracy	30.4	40.8	10.4	25
Hartford,Rebecca	21.6	34.8	13.2	38
Hartford, Kristin	41.0	41.0	0.1	0
Hartford, Dottie	50.5	50.9	0.4	1
			Average =	**30**
All combined	582.2	765.3	183.3	**24**

Energy Savings Results

January 15 through November 15, 2002

		LRC Office (Andy)		LRC Office (Sandra)	
Start	**End**	**Saved**	**Saved**	**Saved**	**Saved**
Date	Date	kWh	%	kWh	%
15-Jan-02	15-Feb-02	6.33	57	7.09	62
15-Feb-02	15-Mar-02	6.17	71	7.18	70
15-Mar-02	15-Apr-02	4.61	64	9.35	68
15-Apr-02	15-May-02	6.04	66	8.74	70
15-May-02	15-Jun-02	6.48	75	9.92	70
15-Jun-02	15-Jul-02	3.53	92	10.67	68
15-Jul-02	15-Aug-02	3.86	64	6.31	54
15-Aug-02	15-Sep-02	6.25	80	12.11	79
15-Sep-02	15-Oct-02	7.99	71	7.41	83
15-Oct-02	15-Nov-02	5.65	54	7.15	51

Occupant Satisfaction
(Interview results)

- No complaints about photosensor operation
  - Some said they liked the dimming, previously too bright
  - One used adjstment to reduce the amount of dimming
- Did not change the way people control their lighting
  - For most, switch on in the morning, off when leaving for the day
  - Most do not adjust blinds daily
  - Some keep blinds closed all the time
- Did not notice dimming
- Noticed switching off of lights
  - Not distracting, though
- All felt they had the same, or more control over their lighting
- Most would want a photosensor in a new office, a couple were indifferent